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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

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THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

TRACTOR LUBRICATION

IN agricultural and industrial production the hauling of materials over comparatively long distances—and, on the farm, the operation of farming machinery itself—forms one of the outstanding problems. Industry and agriculture depend upon the speed and expediency with which the necessary machinery is enabled to function.

Today the tractor proves its worth in every phase of industry and agriculture, both as a tractor or puller and as a pusher of other means of conveyance. Its operation is economical and it can be handled effectively by the most inexperienced laborer after but little instruction. All it requires is fuel, a sufficient amount of water and proper lubrication.

It is important that the tractor be properly lubricated because its duty is heavy—heavier than that of the average motor truck or automobile. Load and speed conditions are so exacting that the slightest defect in the lubricating system or the use of an improperly refined lubricant, or a lubricant unsuited to the service, would engender trouble. For this reason the matter of tractor lubrication must be given very careful consideration.

It has been our purpose in this article to bring out those factors of design, construction and operation which have direct relationship to lubrication. It is felt that by a more complete understanding of the problems involved economy in operation and maintenance will be increased. Circumstances may arise, however, which will require individual consideration in regard to choice of lubricants, degree of refinement, or specific characteristics. It is the purpose of Texaco Engineering Service to afford expert advice in such circumstances. By taking advantage of such service, protection is maintained by the elimination of the cause of trouble before the effect actually occurs.

Operators of Tractors are invited to call on The Texas Company for any information regarding lubrication.

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Tractor Lubrication

Power Economy the Ultimate Objective

WITH the extension of the tractor to virtually every field of industrial production, in addition to its primary function as an adjunct to expansive agricultural development, the demand for increased operating economy and reduction in maintenance costs has become mandatory.

These factors are directly contingent upon lubrication, although this latter has very often been regarded as one of the minor details of tractor operation. It must be realized that failure of an engine bearing, or impaired operation of the gears would lead directly to the necessity of more or less over-haul, and that over the period of time involved, the machine would be out of service, resulting in loss of time in the carrying out of its intended functions.

All this calls for a realization of the intensity of the operating conditions to which the average tractor will be subjected in industrial or agricultural service. These conditions have been anticipated by the tractor industry and design and construction have been studied accordingly.

As a result, the tractor today is a very accurately built piece of machinery, with every practicable provision for protection of its wearing elements. In view of this fact, the same thought should be given by the owner to proper maintenance during operation, as has been devoted to its design by the builder.

It is not enough to assume that all that is necessary is the addition of a certain amount of lubricating oil to the engine at periodic intervals, and the customary renewal of gear lubricant or grease to the transmission, final drive, and the various other moving parts. It is essential that the lubricants possess characteristics commensurate with the actual operating conditions. Otherwise, there will be considerable possibility of impaired lubrication and the development of abnormal wear, due to the inability of the oil films to prevent the entry of abrasive foreign matter, and the development of actual metallic contact between the moving parts.

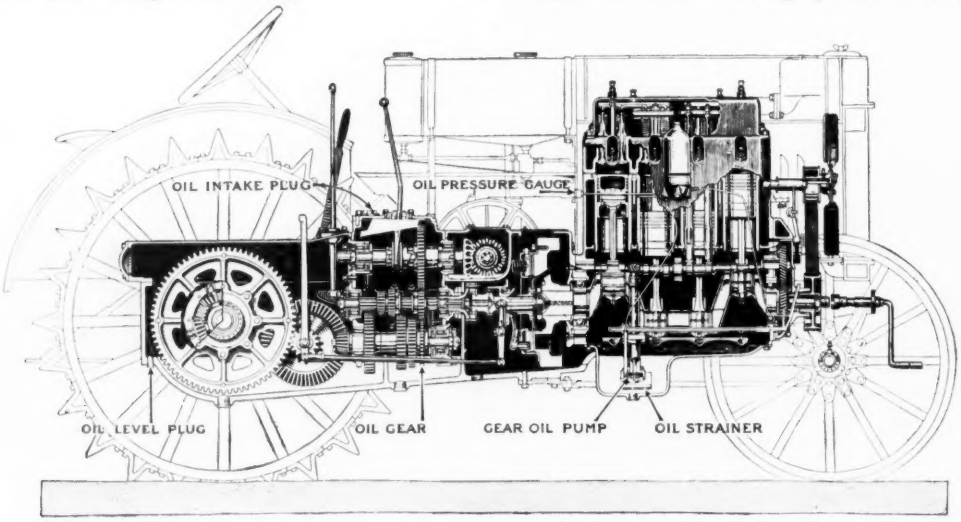
Protection of lubrication does not only involve care in the application of lubricants; it extends back to the actual choice of these products. It is for this reason that the importance of the operating conditions has been emphasized.

Protection of lubrication in operation will depend upon the design of the moving parts and the means available for prevention of loss of lubricants, or entry of foreign matter. In the engine it is obtainable by:

1. Suitable design of bearings
2. Proper arrangement of the oiling system
3. A dependable means of pumping oil to all engine parts
4. The use of an efficient oil filter in connection with the engine lubricating system, and
5. Installation of an air filter capable of removing dust from the air necessary for combustion.

Elsewhere on the tractor, protection of lubrication is obtainable by:

1. Proper construction of gear casings, universal joint housings, etc.
2. Suitable design of bearings



Courtesy of International Harvester Co. of America, Inc.

Fig. 1—Sectional view of a tractor, showing the details of engine, transmission and final drive construction. Note that the salient parts requiring lubrication are clearly indicated.

3. Installation of a means of lubrication which will exclude the entry of foreign matter
4. The use of a dust-tight means of applying the necessary lubricants.

FIELD OF OPERATION

Tractor maintenance and the extent to which tractor lubrication can be protected will, of course, be contingent upon the intensity of the duty to which the machine is subjected.

The tractor season used to depend upon latitude. In its early development it was essentially a farming implement. In consequence, it would generally cease to function with the close of the threshing season. It was soon developed as the motive power for the ensilage cutter, however, and later for the operation of farm pumping and lighting equipment.

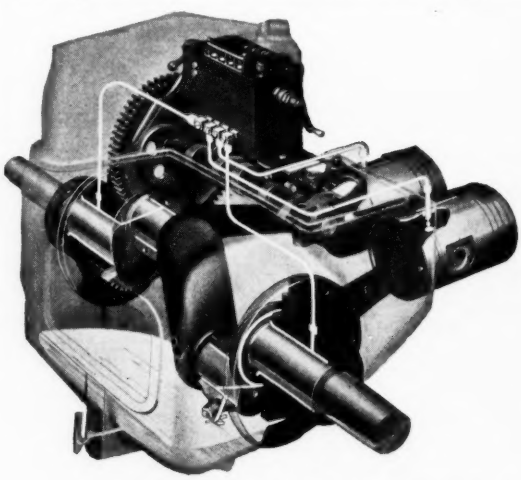
Then its field was extended to the modern industrial plant and it became a year round accessory in the handling of materials. Its ultimate extension to the duties of a snow plough has proved that it is probably the most versatile machine in service today. Such a wide spread range of operation of necessity requires more thought in regard to the matter of maintenance.

The problems involved in protection against abnormal wear will be decidedly varied. When the tractor was essentially a farming implement, the problem of protection of the wearing parts against the abrasive effects of dust and dirt was uppermost. The extension of the machine, however, to the metal working trade, the iron and steel industry, and the handling of snow, has led to the necessity for considering other problems, such as temperature variation and the development of abnormal pressure on certain of the moving parts, during some phases of operation. These, of course, will all have a direct influence upon lubrication.

TRACTOR DESIGN AND CONSTRUCTION

Design and construction, from the viewpoint of the owner and operator, will require a comprehensive understanding of:

1. The extent to which lubrication is provided for in the modern tractor



Courtesy of Advance-Rumely Thresher Co., Inc.

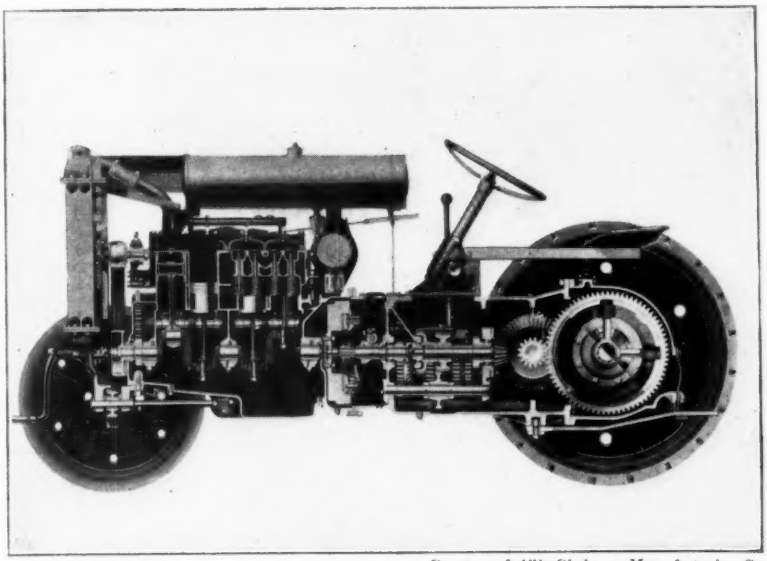
Fig. 2—Phantom view of the dual lubrication system used on the Oilpull tractor engine. This involved both force feed lubrication and splash from the crankcase. The lubricator shown at the top forces fresh, cool, clean oil to the main and connecting rod bearings, cylinders, pistons and piston pins. From these parts oil works down into the crankcase to maintain a shallow oil reservoir in the bottom, into which the connecting rods dip to churn up a heavy mist.

2. The benefits to be derived from such knowledge, especially when selecting lubricants
3. The degree to which the manufacturer has appreciated the operating conditions and planned the design to prevent contamination of lubricants as far as possible.

ENGINE LUBRICATING SYSTEMS

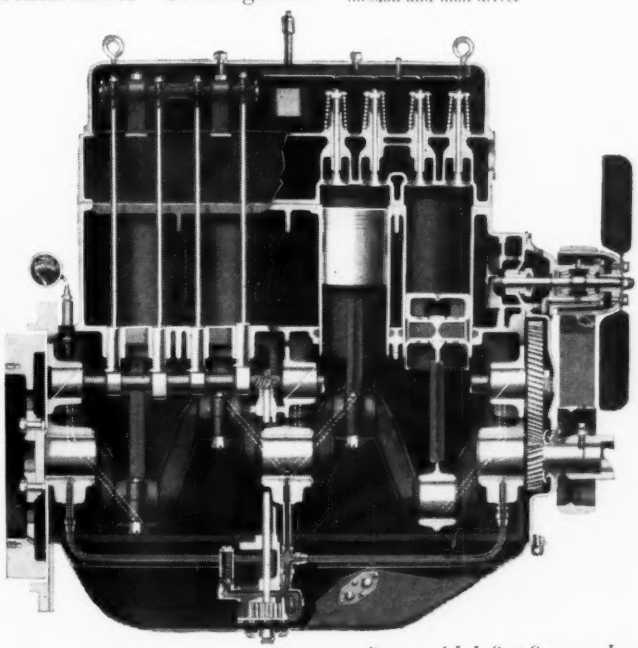
Standardization of design in planning on the lubrication of a tractor engine has been patterned along the same lines as followed in the development of the automobile engine. As a result, we will find the tractor engine employing circulating full pressure, force feed or splash oiling systems, according to the particular type involved.

In addition, however, the tractor designer has departed from automotive practice to the extent of considerable investigation of the adaptability of the mechanical force feed lubricator.



Courtesy of Allis-Chalmers Manufacturing Co.

Fig. 4—Complete cross sectional view of a tractor, showing the relationship of the engine, transmission and final drive.



Courtesy of J. I. Case Company, Inc.

Fig. 3—Sectional view of a pressure lubricated tractor engine, showing the gear pump in the base of the crankcase and the leads therefrom to the respective bearings. This pump is submerged in oil. This insures that it is primed at all times. Oil is forced under pressure to all the principal wearing surfaces as shown. In addition, lubrication is amplified by oil spray, thrown from the bearings.

Circulating systems, of course, involve continued usage of the oil in the crankcase over the life of the particular oil. With the mechanical force feed oiler, on the other hand, continuous delivery of fresh oil to the cylinders and bearings is attained.

The full pressure system of lubrication is preferred by many in view of the fact that a sufficient amount of oil is assured to all moving parts when the engine is running, and no oil is wasted, or discarded until its lubricating value has been so reduced as to render this advisable.

In this system it is hardly necessary to state that oil is forced to the various engine parts to be lubricated under a controllable pressure by means of a suitable pump (usually of the geared type), which is located in the oil reservoir.

Splash lubrication by oil from the reservoir in the crankcase is a somewhat simpler means of bringing about effective lubrication of engine parts, the oil circulating back to the reservoir by gravity for re-usage.

From the viewpoint of engine hours operated this oil should be changed every 40 to 60 hours when using gasoline as a fuel: or every 30 to 40 hours when using kerosene.

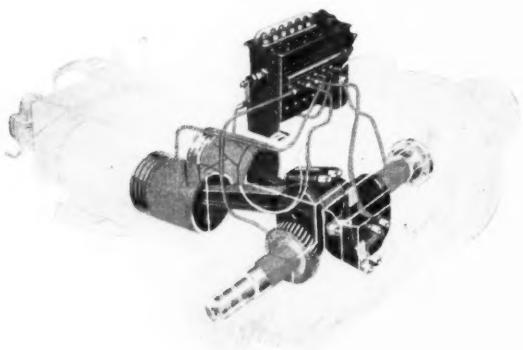
In other respects, lubrication of tractor engines by circulating oil feed in some form or other is so akin to that of the automobile engine that further description of systems, etc., is unnecessary.

Mechanical Force-Feed Lubricators

Mechanical force-feed lubricators of the external types which are designed to feed fresh

oil drop by drop to the cylinders and main bearings, have been used more or less extensively in tractor practice for many years.

Such devices surmount the difficulty of crankcase dilution by furnishing a supply of



Courtesy of Oliver Farm Equipment Co.

Fig. 5—Showing the Hart-Parr fresh oil force-feed system of Tractor engine lubrication. The oil pipes which lead from the lubricator to the main bearings and pistons insure effective lubrication and enable the burning of heavier fuels.

fresh oil constantly to each bearing and cylinder, via individual plunger pumps and oil ducts. This method of lubrication is very similar to that so commonly employed on many types of reciprocating steam engines, etc., today. The oil flow is absolutely controlled in its intensity, as well as in its starting and stopping, by the engine, since the lubricator pumps are driven directly by the latter.

To supply fresh oil to the bearings when the engine is not running, the mechanical lubricator is usually provided with a hand crank. This should always be operated prior to starting in order to insure that sufficient oil will have reached the bearings to maintain lubrication until the engine has put the lubricator pumps in operation.

The question of oil flow or travel through exposed piping in cold weather is often raised when considering the proper viscosity for winter service. The travel of oil, however, through such exposed piping, as the mechanical lubricator will involve, does not depend on viscosity. An efficient oil pump will even force grease through such piping against pressures of approximately 1,000 pounds per square inch. It is the drawing in, or suction, of the lubricant into the pump chambers which involves the viscosity or fluidity of the oil, as is true of any pump in any type of oiling system.

The advantage claimed for the external mechanical force-feed lubricator is that a regular, predetermined supply of clean fresh oil, free from fuel contamination and dust, is furnished to all cylinders and bearings. As a result, the effects of crankcase dilution are eliminated since the oil which drains from these wearing parts is not used again as an engine lubricant. Oftentimes it is used, however, for rough machine lubrication as on gearing, etc.

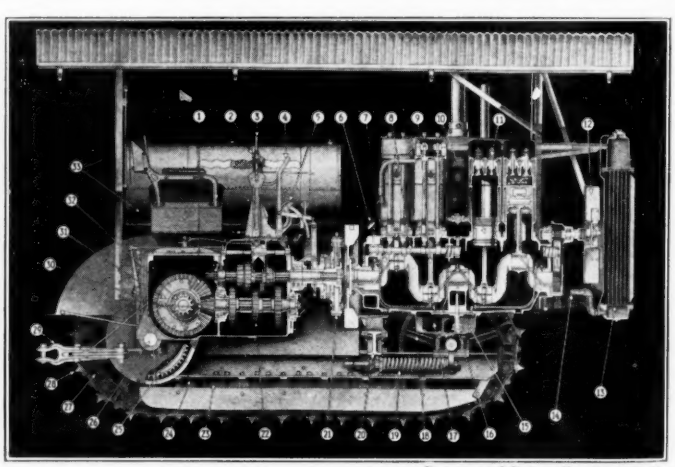
The question is frequently raised as to whether this procedure is more wasteful than the discarding of the entire contents of the crankcase every few days when a circulating system is employed. The answer is, of course, "Yes and No," with certain provisos.

In the event of using a suitable oil in an engine where crankcase dilution is not excessive, more oil might be wasted by the external mechanical lubricator. On the other hand, the reverse may also often be true where the operator is careless, crankcase dilution excessive, or a low grade of fuel used, entailing much priming and the firing of a rich mixture.

OPERATING CONDITIONS AN INFLUENCING FACTOR

The development of tractor engine lubrication has been impelled by the wide variety of operating conditions, to which the average tractor may be subjected, as has already been mentioned.

It is especially essential that one know in advance, when selecting an oil for a particular type of lubricating system, just how the oil will act, not only on starting, especially in cold



Courtesy of Caterpillar Tractor Co.

Fig. 6—Diagram chart of the "Caterpillar" 60 Tractor. Among the parts involved in lubrication are (6) the oil pressure gauge, (15) the oil sump, (16) the oil pump, (17) the oil screen. At (22) is shown the change speed gears and at (25) the final drive gear.

weather, but also the degree to which it will lend itself to complete circulation and maintenance of a protective film between the wearing elements, when subjected to the bearing pressures developed during actual operation. Ease

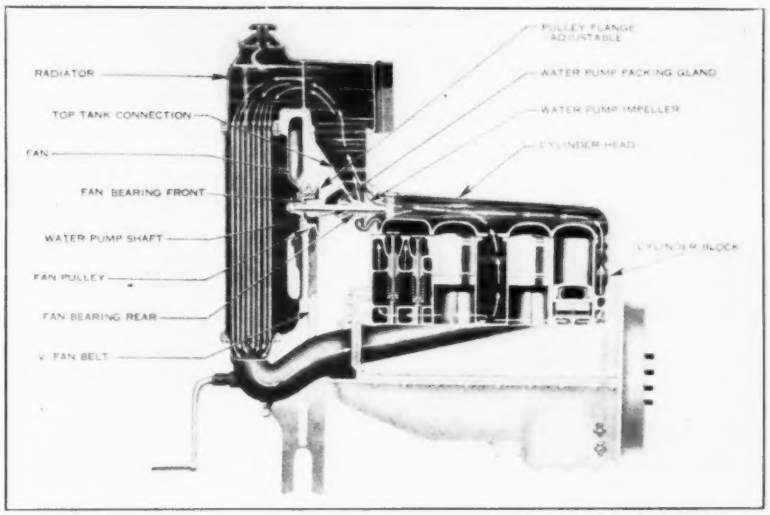
in starting involves both the viscosity and the pour test.

It can be appreciated that if the oil is too heavy in body, or of too high a pour test under low temperature conditions, it may not pump readily throughout the system. There may also be the possibility of congealment within the bearing clearances and on the cylinder walls, to render the engine virtually incapable of being turned over at the start.

As a result, both the pour test and the viscosity must be carefully studied at the starting and operating temperatures. It is evident that a tractor oil must possess these characteristics to the proper extent. Otherwise, it may be unsatisfactory for the duty involved. Even perfect suitability in either one case or the other does not recommend its usage in any but exceptional instances, for an abnormally high pour test or a viscosity unsuited to the starting temperature may lead to ultimate trouble.

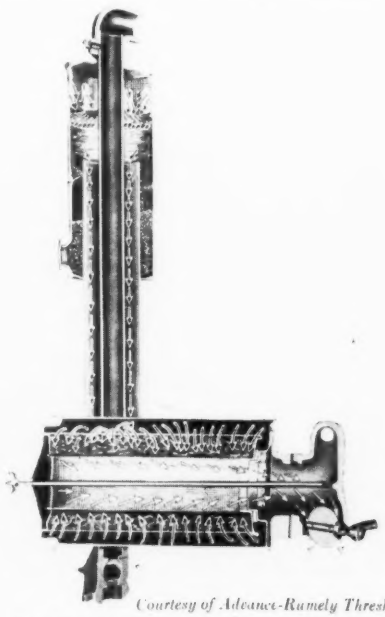
Where mechanical force feed oilers are used in cold weather, particularly on the larger engines, an oil must be chosen which when cold will be sufficiently fluid to be drawn into the pump units. Yet a heavier oil might be theoretically better, if the development of a lubricating film alone is to be considered.

It can, therefore, be appreciated that there are certain outstanding benefits to be derived from adequate knowledge of tractor engine design and construction and lubricating oil characteristics. Accordingly, it will be advisable to discuss these latter in some detail, as well as the requirements which may be imposed.



Courtesy of Ford Motor Company

Fig. 8—Sectional view of a Fordson engine, showing in part path followed by the cooling water as it passes through the engine.



Courtesy of Adeance-Rumely Thresher Co., Inc

Fig. 7—Showing the two stage air cleaner employed on the Oilpull tractor. In this device air is first passed through a centrifugal separator and then through an oil soaked moss-type filter. Arrows indicate course of air flow.

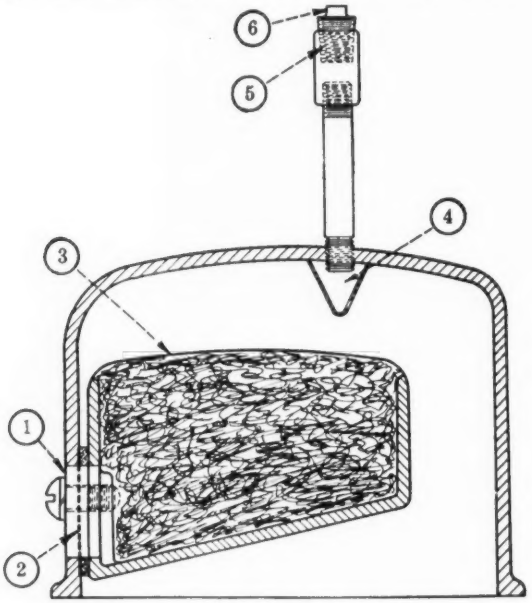
Relation of Viscosity, Pour Test and Carbon Residue to Operating Performance

In view of the attention which should be given to the above characteristics in selecting any oil for tractor lubrication, the actual meaning of these terms must be understood.

The viscosity or body of an oil, as it is generally understood, is of considerable importance, especially where a tractor must function in warm weather or under intensive operating conditions. The viscosity will have a decided effect upon oil consumption. To realize this, it is essential to appreciate that lubrication requires the development and maintenance of a suitable film of oil on the cylinder walls and within the clearance space of all the bearings at the temperature of operation. Under normal conditions, these latter will not exceed 300 degrees Fahr.

On the other hand, when a tractor is used for threshing, the engine may operate at a stand-still, and the cooling capacity of the radiator will be somewhat lower than where the machine is in motion. As a result of this,

higher engine temperature may develop. These latter improve combustion of the fuel, although it is important to remember that the operating viscosity of the oil must be such as to lead to the development and maintenance of an ade quate lubricating film under such temperatures.



Courtesy of J. I. Case Company, Inc.

Fig. 9—Showing the crankcase breather and means for valve rocker oiling on the Case Model "L" tractor. (1) is the breather opening, (2) a screen for this opening to prevent entry of dust and dirt, (3) the filter medium through which the air passes, (4) a trough which forms an oil reservoir and allows oil to drip to each rocker arm bearing, (5) is an oil filling pipe, equipped with a pipe plug (6). This should be filled once or twice a week, according to the extent of the operation of the machine

Viscosity Defined

Viscosity is regarded as a measure of the relative fluidity of an oil at some definite temperature of observation. In brief, it is that inherent property by virtue of which the flow of certain liquids will be retarded. It is possessed by all lubricating oils.

From a technical viewpoint, viscosity can also be regarded as a measure of the resistance which the particles or molecules of an oil will offer to one another as they come into contact in circulation through the lubricating system or between the wearing elements. Viscosity will vary inversely with temperature, i.e., the colder an oil the heavier or more sluggish will it be. In contrast, it will become more and more fluid as the temperature is raised.

Reasons for Higher Viscosity Requirements

Modern conditions of intensive operation will involve higher tractor engine temperatures. These will lead to an increase in the degree of fluidity of the engine oil which is used for lubrication. Especially will this be true in warm weather, when the amount of external cooling will be appreciably lower than in cold weather, or when the tractor is serving as the driving element for stationary machinery, such as the threshing machine.

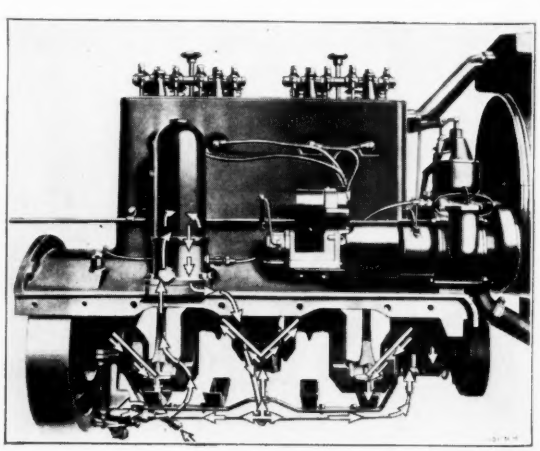
The utmost care must, therefore, be taken in the selection of the proper grade of tractor oil for warm weather operation. Haphazard choice may be the forerunner of too great a reduction in the fluidity of the oil in service, with oftentimes ineffectual lubrication of certain of the wearing parts of the engine as well as abnormal increase in the rate of consumption.

The ultimate occurrence of scored or burned out bearings, of abnormal wear on cylinder walls, and an excess of oil pumping past the piston rings, will all lead to increased cost in maintenance and a natural decrease in power output.

Definite Information Necessary

In view of the importance of the viscosity characteristic, the tractor operator should know the approximate range of viscosity involved when he buys a grade of "heavy" tractor oil, for example, regardless of by whom it is manufactured.

Furthermore, he should know that when an oil is stated as having a viscosity of say 75 seconds Saybolt at 210 degrees Fahr., this means that the body or relative fluidity of the oil in question is such that, at a uniform temperature of 210 degrees Fahrenheit it will take 60 cubic centimeters of this oil 75 seconds to flow through the orifice of the standard Saybolt Universal Viscosimeter.



Courtesy of The Massey-Harris Co., Inc.

Fig. 10—Side view of a Wallis tractor engine. Arrows show path of oil circulation under pressure.

THE EFFECT OF CARBON RESIDUE

Petroleum products are hydrocarbons; as a result, carbon in some chemical form must pass through every automotive engine. It is only a detriment, however, in the form of soot or

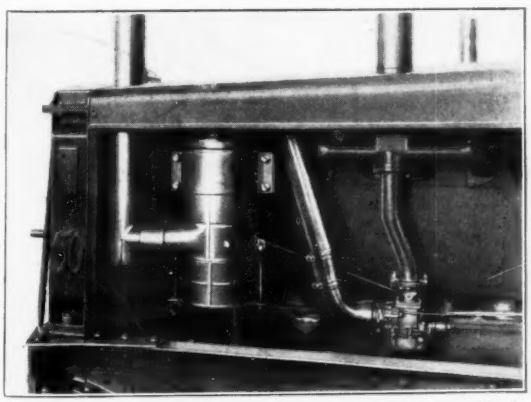
deposits of carbonaceous tarry matter, which may result from evaporation.

Carbon residue may have a very decided effect upon the operation of the engine, the amount of power developed and the amount of "knocking," according to the extent to which deposits are formed on the spark plugs, pistons, cylinder heads, around the rings, on valves and valve seats.

Heat and Base of Crude

The amount of carbon residue developed will depend entirely upon the degree of heat present, the extent of refinement of the lubricant and the crude from which it is made. From particular types of crude, for example, distillates can be produced which will show an almost negligible carbon residue, 0.05 being a fair idea of the amount to be expected. The use of residual oils, however, for the purpose of blending and increasing the viscosity may raise the carbon residue percentage of the resultant product to one per cent or above. Lubricants of this nature will be dark green in color and comparatively opaque.

Carbon which is developed from blended oils containing residual products will, unless specially refined, be harder and more abrasive than carbon residue from lubricants of equal viscosity, but which are wholly of a distilled nature. Hard abrasive carbon does its greatest damage as a promoter of wear on cylinder walls and bearings. Very frequently it will be developed on the upper part of the cylinder walls to be retained by the lubricating film and ultimately work past the piston rings and into the lubricating system.

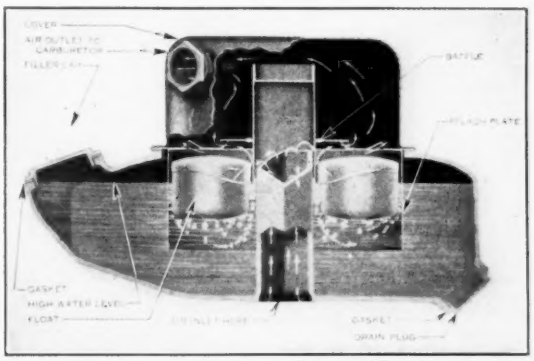


Courtesy of Allis-Chalmers Mfg. Co.

Fig. 11—Side view of an Allis-Chalmers tractor engine, showing the air cleaner in position.

All true carbonaceous deposits in the average automotive engine do not, of course, originate from the lubricating oil. Incomplete combustion of the fuel, or an abnormal amount of dilution of the lubricating oil will also tend to increase the amount of carbon formation in the combustion chamber.

Furthermore, the lighter the lubricant or the thinner the film on the cylinder walls, the more readily will it splash or succumb to the wiping effects of the piston. This will, of course, increase the possibility of pumping or forcing of the lubricating film up into the combustion chamber, where it will ultimately be burned. The direct result is the development of more or less carbon and increased oil consumption.



Courtesy of Ford Motor Company

Fig. 12—Showing the Fordson air washer. The purpose of this device is to remove the dust and solid matter from the air before it enters the engine. This will prevent excessive wear on pistons and cylinder walls. It is also intended to moisten the air, which is an aid in avoiding pre-ignition in the firing of the mixture in the cylinders.

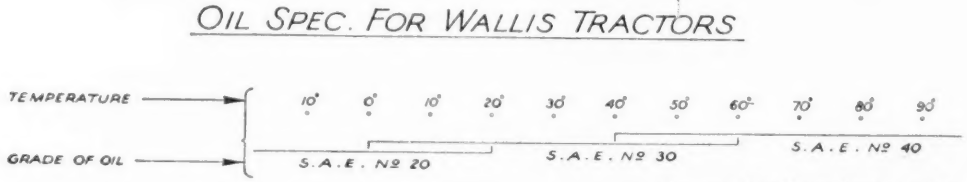
How extensive these deposits may be will, of course, depend upon the residual carbon content of the oil. Where the latter burns cleanly the amount of such deposits will be relatively small. Furthermore, if the oil is properly refined and adapted to the purpose, such carbonaceous matter will be soft in appearance, low in quantity and easily removed when cleaning is necessary. Over extended periods of operating, however, carbon deposits, whatever their nature, will be bound to increase.

How Excess Lubricating Oil May Act

Just how an excess of lubricating oil may cause abnormal carbon deposits will be of interest. Theoretically, a very small amount of oil is necessary to maintain the requisite lubricating film on the cylinder walls and serve the respective bearings; actually, however, a considerable excess of oil will be used. Where the rings give the proper degree of seal and the cylinder walls are not abnormally worn, but little of this oil should pass to the combustion chamber. If the oil level is carried too high, however, especially in oiling systems involving splash lubrication, the amount of oil on the cylinder walls may be so excessive that a certain percentage cannot help but find its way into the combustion chamber. A smoky appearance of the exhaust will frequently be an indication of this.

TRACTOR ENGINE OIL REQUIREMENTS

The selection of tractor lubricants which will assure continuous and efficient operation necessitates a clear understanding of the requirements of tractor builders. As the latter have developed improvements in tractor design so have the oil refiners kept pace wherever necessary in producing oils and greases of suitable characteristics and greater refinement.



Courtesy of The Massey-Harris Co., Inc.

Fig. 13—Showing a chart whereby the grade of oil for a Wallis tractor can be determined, according to the operating temperature. S. A. E. No. 20 involves an oil of from 120 to 150 seconds Saybolt at 130 degrees Fahr., S. A. E. No. 30 indicates an oil of 185 to 220 seconds Saybolt at the same temperature, and S. A. E. No. 40 involves an oil of 255 seconds Saybolt, also at 130 degrees Fahr., or 70 seconds at 210 degrees Fahr.

quirements which they must satisfy. From at least a theoretical point of view, the engine will be the most difficult part of the machine to lubricate, though manually, it will frequently be the easiest. Perhaps this is why so many operators often fail to appreciate the extreme importance of proper engine lubrication.

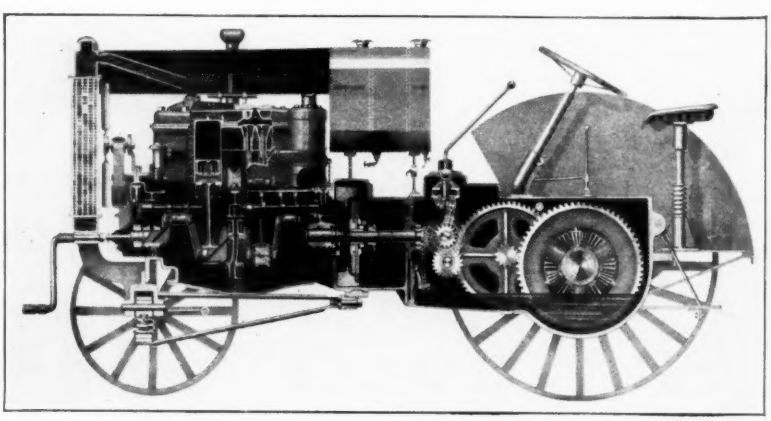
The fact that intensive duty is so often imposed places very exacting requirements upon both the oil and lubricating system. To meet these conditions, the petroleum industry has carried on extensive research and refining investigations to prove that it is possible to refine lubricants from petroleum which will meet working conditions, however exacting, and conform to tractor engine construction, however intricate.

Under average operation the tractor owner, especially in agricultural work, will have practically no means of checking the suitability of his lubricants, or the extent to which effective lubrication is taking place. This is, however, the province of the research laboratory. The tractor owner should not have to worry, any more than the average motorist does, provided he takes care to purchase such products from reputable oil marketers with national reputation and distribution.

Essentially the trademark is his protection, and a veritable insurance of his tractor engine, bearings, gears and chains, against premature deterioration due to abnormal friction. For the degree of cooperation existing between the tractor builders and the leaders in the petroleum industry has been marked. The latter are continually bending every effort to meet the lubricating requirements of tractor builders. As the latter have developed improvements in tractor design so have the oil refiners kept pace wherever necessary in producing oils and greases of suitable characteristics and greater refinement.

Certain of the outstanding requirements of tractor engine oils, in particular, are so important and certainly of so much interest that it is well to outline them in brief, as they are viewed by the authorities in the field of tractor lubrication. A better understanding of them will enable the progressive tractor operator to discuss the matter of lubrication more intelligently and appreciate its decided importance as related to efficient and economical operation. They will involve:

Lubricating ability and seal-forming properties,
An ability to withstand heat,
Adequate fluidity at low temperatures, and
Viscosity commensurate with the operating conditions.



Courtesy of Rock Island Plow Co.

Fig. 14—Showing details of a Rock Island tractor, illustrating the provisions for pressure lubrication of engine parts. Note also the oil slinger chain mounted at the end of the transmission case. This is to thoroughly lubricate the rear clutch shaft bearing, the bevel gears and also the bearings on the belt pulley shaft, for operating the tractor in the belt

Lubricating Ability

By lubricating ability or "oiliness" is meant the extent to which an oil, in accordance with the viscosity, will be able to form and maintain a suitable lubricating film between wear-

ing surfaces. The higher this property the greater will be the insurance against burned out bearings, scored cylinders and the occurrence of metallic friction.

Seal-forming properties are important in that such an oil, to be satisfactory, must form and maintain a sufficient seal between the cylinder walls and piston rings to prevent loss of compression, pumping or blow-by.

Resistance to Temperature

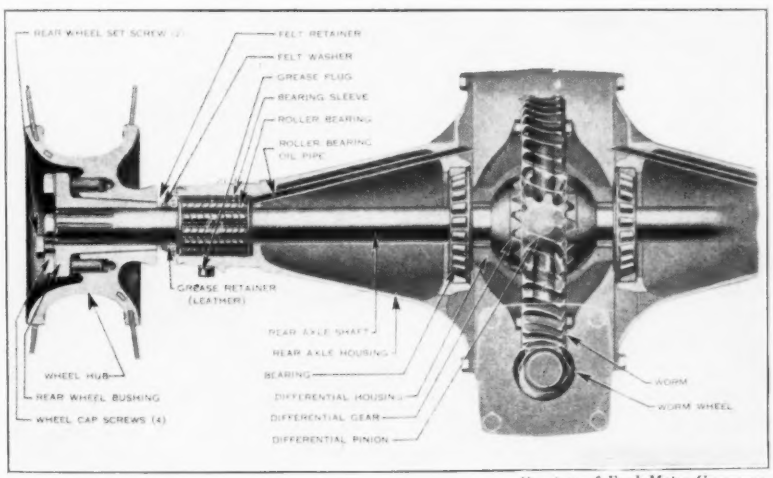
The extent to which a tractor engine oil will withstand heat, is in turn an indication of its resistance to decomposition, abnormal loss in viscosity and burning to hard carbon. A good tractor oil should be capable of working under the usually high temperatures of operation without any of these occurring to a marked degree.

Pour Test or Fluidity

Low pour test is essential in that it is indicative of the action of the oil in cold weather. The lower the pour test or temperature of relative congealment, the more assurance that a tractor oil will have sufficient fluidity to flow readily throughout the oiling system in cold weather, especially on starting. If undue congealment occurs there will be possibility of at least certain of the bearings being more or less under-lubricated, due to faulty operation of the oil pump or lubricator, or imperfect splashing.

Viscosity Insures Resistance to Pressure

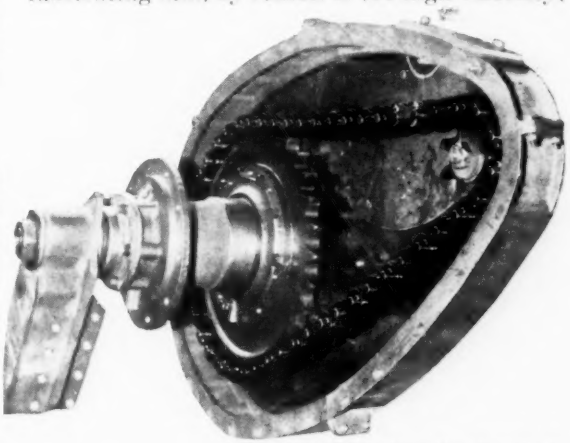
The matter of viscosity is in turn of interest, in that a tractor engine oil, to be satisfactory, must have sufficient body to resist being squeezed out from between any of the wearing parts where pressure may be relatively high, as for example in crankshaft, piston pin and main bearings.



Courtesy of Ford Motor Company

Fig. 15—Showing a Fordson rear axle and wheel assembly. Note in particular the felt and leather retainers to keep grease from working out of the roller bearing.

On the other hand, it is well to remember that the development of abnormal internal or molecular friction, that is friction which occurs between the particles of oil which compose the lubricating film, by reason of too high viscosity, may require excessive power consumption in being overcome. Internal or molecular friction is more or less directly related to viscosity, therefore the latter should be an indication of the degree to which it may occur.



Courtesy of Allis-Chalmers Manufacturing Co.

Fig. 16—Showing details of the chain drive of the Monarch "75" tractor

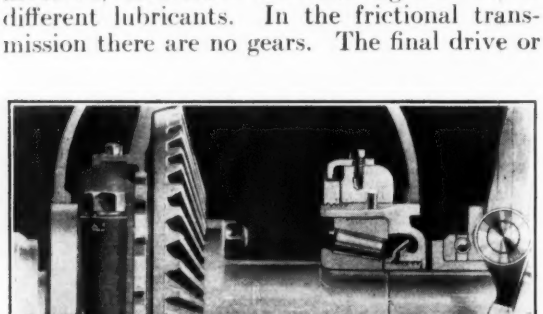
It would be relatively impossible for the operator himself to make any very practical experiments for his own satisfaction. In fact, that would scarcely be necessary for, in reality, a knowledge of the basic oil requirements is all he needs to prove to either his Tractor Builder or Oil Dealer that he knows what he wants. He can then make them prove to him, in turn, the reason why any particular grade of oil will be better than another for his specific conditions.

POWER TRANSMISSION GEARING

The transmission of power from the engine to the rear axle and wheels requires certain speed change and reduction gears in the tractor, as in the automobile. The transmission located between the engine and the differential, or final drive, in the average machine of this type serves the purpose by means of an arrangement of gears, or a frictional transmission device.

From a lubricating point of view the geared transmission requires more consideration, inas-

much as both gear and bearing lubrication is involved, oftentimes necessitating the use of different lubricants. In the frictional transmission there are no gears. The final drive or



Courtesy of Caterpillar Tractor Company

Fig. 17—Showing the bevelled gear and bearing on a model 60 Caterpillar tractor

differential, however, involves the use of worm, spur, bevel or annular gears.

Transmission and rear axle lubrication is essentially a matter of combined gear and bearing lubrication, wherein the lubricant must serve a dual purpose. In the majority of tractors today the transmission is enclosed in an oil tight casing and bath lubrication is made possible. When the tractor is in motion the service on both gears and bearings is very severe, so a lubricant must be used of just the right viscosity or body to not only insure adequate penetration throughout all the bearings to furnish the requisite oil film with a minimum of internal friction, but also to protect the gear teeth from wear and to reduce noise during operation. In the geared transmission power is usually transmitted through two distinct gear reductions.

In view of the above, there is a certain amount of latitude relative to the viscosity or body of the lubricant, which should be used in a geared transmission. The controlling elements are the type of bearings and constructional conditions involved. Where installations are equipped with anti-friction bearings on the gear shafts a straight mineral tractor oil, ranging in the neighborhood of from 500 to 750 seconds Saybolt at approximately 100 degrees Fahr. will often give the best results.

Others, wherein similar bearings are used, but so located that individual lubrication is possible, will frequently require grease lubrication of the bearings, the gears in turn being served by a straight mineral gear lubricant of from 120 to 180 seconds Saybolt viscosity at 210 degrees Fahr. Still other installations, on account of design, wear or arrangement of gears, may require an even heavier lubricant of 200 seconds Saybolt at 210 degrees Fahr.

Oil Level Important

Where using heavier gear lubricants, the gear case should never contain more than just enough to insure that the teeth of all gears on the lowest shaft of the transmission will dip in the lubricant. This will promote the most effective lubrication; any increase in the amount of lubricant in the case will impose a "drag" on the gears, especially in cold weather. Where slow motion is involved, however, certain authorities disregard "drag" and recommend that the level of the lubricant be raised until certain of the higher gears are submerged.

In this connection it is interesting to note that the builders of one type of extensively used tractor, wherein the transmission and rear axle are lubricated from the same oil bath located in the transmission case, recommend that the oil level be inspected twice a day, and that fresh oil be added when the machine is warm. When this latter is necessary the oil should be poured in to the level of the filler cap hole. Care should be taken to see that all parts have been reached by this oil before the cap is replaced.

Fluidity Must Be Assured

The pour test of transmission gear lubricants is especially important when the tractor is to be used in cold weather. Even a properly filled gear case is not dependable if the gear lubricant therein has not a sufficiently low pour test to remain comparatively fluid under low temperature operation. In such an event the gears would channel through it, and any lubricant sticking to the sides of the case would not flow readily back to the bottom. The evident precaution is to select a gear lubricant which will have a pour test at least as low as the average operating temperature which will be encountered in cold weather.

Where the transmission is not enclosed a lubricant must be used which will stick tenaciously to the gear teeth and not be thrown off by centrifugal force or affected by water. For this purpose a heavy bodied straight mineral gear compound of from 1,000 to 2,000 seconds Saybolt viscosity at 210 degrees Fahr. should be used.

The Final Drive

While the final drive and differential may include spur gears, internal gears, chains, worm or bevel gears, according to the design of the machine, the spur gear predominates today.

In tractors where the chains or gears operate

exposed and it is necessary to use a gear lubricant of about 2,000 seconds Saybolt viscosity to take up the shock and strain so often incurred, which would squeeze any lighter lubricant out from between the gear or sprocket teeth. Wear and deterioration will be bound to occur through the use of lighter oils or greases, as these would only drip off prematurely.

In driving chain lubrication the lubricant must again serve as a lubricant and as a protective agent. Every care must therefore be taken to saturate wearing parts thoroughly to insure penetration of the lubricant to the innermost elements. For this purpose a straight mineral lubricant having a viscosity of from 500 to 1,000 seconds Saybolt at 210 degrees Fahr. will be best suited. This should be applied hot, preferably by removing the chains and immersing them in a pail filled with the lubricant. They can then be hung up to cool and drain off excess lubricant.

GREASE LUBRICATED PARTS

In view of the fact that certain of the external parts of some types of tractors can be lubricated quite as effectively with grease as with oil, depending upon the means of lubrication provided, it is advisable to study this matter carefully.

The use of grease as a lubricant on the average tractor will be confined to those parts which would normally be known as chassis parts on the automobile. It is becoming more and more customary to provide these parts, which include the bearings of the axles, fan, link pins, rollers, and the steering mechanism with means of pressure grease lubrication, by use of a hand or power gun, although the compression grease cups, of course, is still used.

With the exception of the front and rear wheels, which are equipped with ball or roller bearings, the above parts will in general comprise plain or sleeve type bearings.

It is important to keep these elements properly lubricated if the tractor as a whole is to function as an efficient unit. The requirements involved in a grease for such service are not so exacting as in the case of engine oils. On the other hand, one should not go to the extreme in the belief that any cheap grease will suffice.

Adequate protection will be attained if the essential characteristics of a grease, such as its melting point, consistency and the nature of the soap from which it has been made are studied in connection with the operating conditions.

As a general rule, some of the bearings will be exposed at the ends, allowing for a complete flow of grease through the clearance spaces. If the grease is of the proper consistency to remain in position at such points a protective collar will be developed which will very effectively prevent entry of dust or dirt into the adjacent bearing spaces.

Courtesy of International Harvester Co. of America, Inc.

Fig. 18—Showing means of grease application by use of a pressure gun to the front axle of a tractor.

Consistency

It will be well to understand, therefore, just what is meant by consistency. In the petroleum industry this is regarded as indicative of the body or degree of hardness of the grease. It also serves as an indication of the texture. For example, cup greases will usually have a short fibery or buttery consistency, whereas a sponge grease will have a long fibery or spongy consistency. They will vary in hardness, however, according to the amount and nature of soap used in their manufacture, as well as the method employed.

Consistency of comparatively non-fluid greases can be determined by use of the penetration method. It involves a device known as a penetrometer, equipped with a suitable cone which is allowed to drop into the product to be tested. The depth to which this cone penetrates a sample of grease over a period of 5 seconds at a definite temperature is read in terms of hundredths of a centimeter on a suitable scale, and reported as the penetration of the particular sample.

It is obvious that the harder the grease the less readily will it be penetrated by the cone. In other words, the depth of penetration will vary inversely with the approximate degree of hardness of the grease.

For average tractor service the penetration should range between 200 and 300.

Melting Point

The melting point of a grease is indicative of the extent to which it will stand high temperatures. It is obvious that if bearing tem-

peratures should run comparatively high, the melting point of any grease to be used under such conditions should be sufficiently above the average temperature to insure against reduction of body and the possibility of separation of the soap from the oil. There are certain types of such products which cannot be heated very much above their melting point without the danger of such separation occurring.

In this regard it is well to remember that the melting point of a grease is controlled by:

1. The nature of the fatty oil used
2. The nature of the base, and
3. The percentage of soap.

The nature of the alkali used, i.e., whether it is lime, caustic soda or other such material, influences the melting point more than do the other factors. In general, lime soap greases are of comparatively low melting point, whereas soda products will have fairly high melting points.

Melting point is commonly determined by what is known as the drop test. In making this test a small amount of the grease is placed on the bulb of the thermometer, and suspended in a test tube. The tube is slowly heated and the temperature at which the grease melts and drops off the bulb of the thermometer is taken as the melting point. This test may be sometimes misleading however, for there are some greases which have no real melting point.

Influence of Pressure and Speed

In view of the fact that in tractor service greases are chiefly of advantage in lubricating the normally slow speed elements, wherein high pressures may be involved, and a comparatively thick film of lubricant is desirable, it might be inferred that such products would be unsuited to higher speed conditions.

Theoretically, grease lubrication is best suited to slow speed service, especially where plain bearings are involved, by virtue of the fact that a grease film is normally thicker than an oil film. It is uncertain, however, whether this would hold true under comparatively high speeds since the questions of pressure, bearing area and means of application must be considered. In this connection, it is interesting to note that certain types of fairly high speed anti-friction bearings can be very effectively lubricated by grease if the characteristics and components of the products have been studied in connection with the requirements.

Stability must be given very careful consideration, for it is most important that a grease retain its intended homogeneity of mixture throughout its entire life.

It must be remembered that unless a grease has been skillfully and scientifically mixed, and the highest grades of ingredients used, there may be a tendency towards lumpy separation of oil from the soap constituent. Such an occurrence will be especially likely if the grease is stored over any length of time, or subjected to comparatively wide temperature variations. It will, of course, lead to impaired lubrication.

Separation, however, may also be caused by the use of an excessive amount of heat in mixing, or by improper handling at this time.

Means of Grease Lubrication

While the compression grease cup is still rather extensively used on some types of external wearing parts of certain tractors, it is being supplanted by the pressure gun fitting by many builders. Both, however, involve much the same principles of operation, although by means of the latter there will be more assurance of a bearing being continually and completely filled with fresh, non-contaminated lubricant. At the same time, the act of re-lubrication insures expulsion of old grease and any contaminating matter which it may have absorbed.

The compression grease cup supplies grease to a bearing by virtue of a certain amount of pressure, which is exerted upon the grease by means of a screw down cap. While pressure is essentially the means of delivering grease to a bearing, the actual distribution within the clearance space may be aided by the motion of the moving element, capillary action, heat and vibration during operation.

Pressure Lubrication

Lubrication by means of the grease gun requires the use of some form of fitting or nipple equipped with a ball check valve to insure retention of the lubricant. By constructing the exterior of this fitting to conform with the design of the discharge nozzle of the pressure gun, it is practicable to render lubrication virtually automatic, and absolutely controllable upon attachment of the compressor or power lubricator.

Pressure lubrication of this nature is comparatively simple for it facilitates the handling of grease in a cleanly and expedient manner.

It furthermore enables the ready forcing out of deteriorated, contaminated or gummed grease, which otherwise would be a decided hindrance to effective lubrication. This is, in fact, one of the essential advantages of grease lubrication by means of pressure lubricators.

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